Sandia BOS Testing

BRIEF

#4, Mar 1997

FCC Part 15 Rules and PV Systems

Published by Sandia National Laboratories PV Systems Assistance Center This work funded by the DOE Photovoltaic Division

Background

The Federal Communications Commission CFR 47, Rule 15 (10-1-95 Edition) limits radio frequency (RF) emissions from products that use digital technology (see Dec 93, OET Bulletin 62 for a simplified discussion). The rules define Class A products (for use in business/commercial applications) and Class B products (for use in residential environments). The FCC limits on emitted RF are:

Conducted

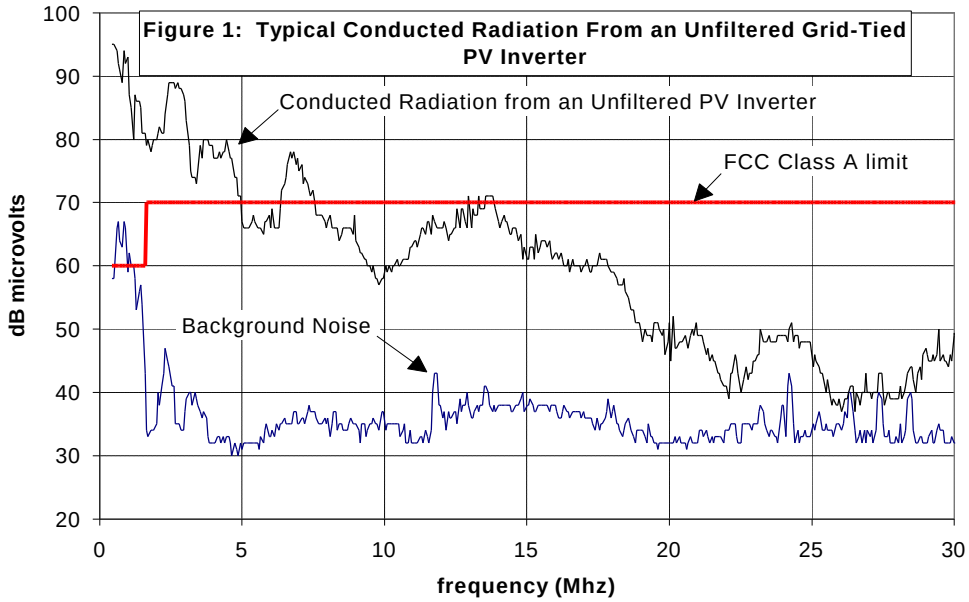
frequency (MHz)	Class A (µV)	Class B (µV)
.45 -1.705	1000	250
1.705-30	3000	250

Radiated (3m)

frequency (MHz)	Class A (µV/m)	Class B (µV/m)
30-88	300	100
88-216	500	150
216-1000	700	200
> 960	300	500

Typical Unshielded Inverter RF Emanations

SNL measurements of RF have seldom identified a PV inverter that has a compliance problem with radiated RF; however; all of the unfiltered inverters have a compliance problem with conducted RF. Proper filtering is provided by a combination of good design and commercially available filters. Compliance with FCC Part 15 radiated specification is not a guarantee that there is no interference. Many radio receivers operate below the 30 MHz cutoff of the specification (including the entire AM radio band) and interference with radios, garage door openers, and etc. may still be a problem. Operation in close proximity to such devices can help identify potential problems. The RF response of a typical unshielded PV inverter is shown in the figures below. The radiated RF is below the background level and therefore is not seen in figure 2.



RF Emanations Evaluation Techniques

PV installers or users may want to quantify RF emissions from an inverter without an elaborate certification procedure. The measurement of RF from large PV inverters is complicated by large output power, and by the requirement for a direct current source. Power supplies are frequently the source of large amounts of RF themselves, and thus should be avoided, during RF evaluations. Either batteries or a PV array will supply a

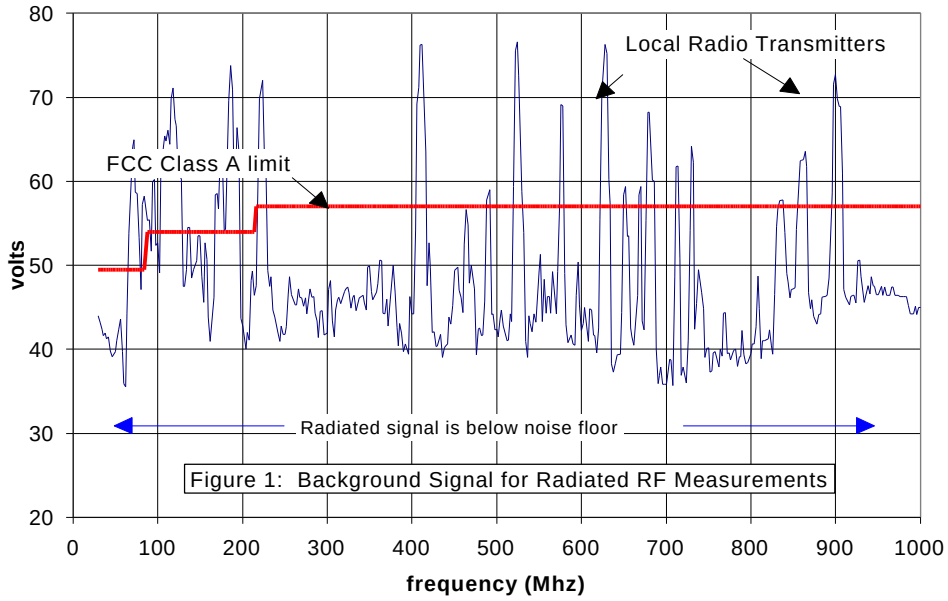


Figure 1: Background Signal for Radiated RF Measurements

suitable source of dc power. For large systems, the dc source can be difficult to provide in an area that is both remote (the FCC recommends a remote test site) and convenient to the inverter developer. Additionally, line isolation stabilization networks (LISNs) are not commercially available in large wattage. However, a basic understanding of the RF issues does permit an accurate measurement at the installation site. The following methods provide reasonable measurements.

Conducted Measurements. A wide band spectrum analyzer or micro-voltmeter is used to measure the detected RF. Although a LISN is generally required as the transducer, a line probe may be used for voltage measurements when a LISN is not commercially available. The LISN has two functions. First, since the line impedance varies from one installation to the next, it provides a uniform termination impedance to the line under test. Second it prevents RF from contaminating the line. The line probe simply provides a high impedance to 60 Hz and measures the RF voltage directly. However, for inverters with high switching frequencies, damage to the probe can occur if the series resistance of the line probe provides inadequate isolation at the switching frequency. The line probe provides the correct measurement for the site being measured, but since the line impedance of different sites may vary, a slightly different measurement may be obtained at a new location. The line probe has an impedance of 50 ohms in the radio frequency bands; thus the line probe impedance at radio frequencies is always high with respect to the line impedance that it parallels. This fact ensures that measurement differences between sites are minimal. At radio frequencies the power lines are a nonuniform transmission line with losses. For this reason the distance from the inverter to the measurement point is important. A system qualified with 2 feet of line between the measurement point and the inverter will always qualify for longer line lengths, but the reverse is not true.

Radiated Measurements: Again, a wide band spectrum analyzer or micro-voltmeter is used to measure the detected RF. A special wideband antenna is used as the transducer. The FCC recommends that radiated tests be conducted in a remote area, far from the source of RF signals. This is not always practical for PV inverters. PV inverter noise is broadband (figure 1) and does not result in radiated spikes of RF noise. Thus, the presence of radiated spikes does not prevent detection of inverter generated RF. If radiated RF noise is of a significant amplitude, it would result in raising a broad section of the noise floor shown in figure two. Turning the inverter on and then off will positively identify the noise due to the inverter. If inverter noise is below the FCC limit, the inverter passes the evaluation.

For More Information: Russell Bonn, 505-844-6710, (Email rhbonn@Sandia.GOV)
Sandia National Laboratories, Albuquerque, NM, 87185-0753